A sampling plan for the North American marsh bird monitoring program

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Introduction

In April, 1998, a workshop was held at the Patuxent Wildlife Research Center to discuss creation of a marsh bird monitoring program for North America. The target species for the program, as described by Ribic et al. (1999) in the Workshop Proceedings, were

> *Primary species:* pied-billed grebe; least and American bitterns; sora; clapper, king, Virginia, black and yellow rails; American coot; purple gallinule; and common snipe
>
> *Secondary species:* herons, cranes, Franklin's gull, black and Forester's terns, belted kingfisher, sedge and marsh wrens, willow and alder flycatchers, common yellowthroat, sharp-tailed and LeConte's sparrows, and red-winged and yellow-headed blackbirds.

Those in attendance concluded that a long-term monitoring program for these species would be useful in addressing many management and research issues. Since 1999, a great deal of work has been carried out to design the proposed survey. A second workshop will be held in March, 2006, to consider whether we are ready to implement the program. This report describes a proposed sampling plan for selecting locations to survey. I attempt to answer the question about design of the survey posed by Francis and Weeber (1999) in the Proceedings of the 1998 Workshop. Other reports summarize management issues the proposed monitoring program would help address, field protocols, and data base design for the North American marsh bird monitoring program.

Focal species and geographic area

Much of the work since the 1998 workshop has been focused on secretive marsh birds. Many groups, however, are developing surveys for other aquatic birds. Some groups survey all species on the same survey; other groups conduct separate surveys for secretive marsh birds and other aquatic species. The sampling plan described in this report can be used for any group of aquatic birds.

Most of the work reported here was done in the U. S. More work will be needed to determine how well the recommendations apply to Canada.

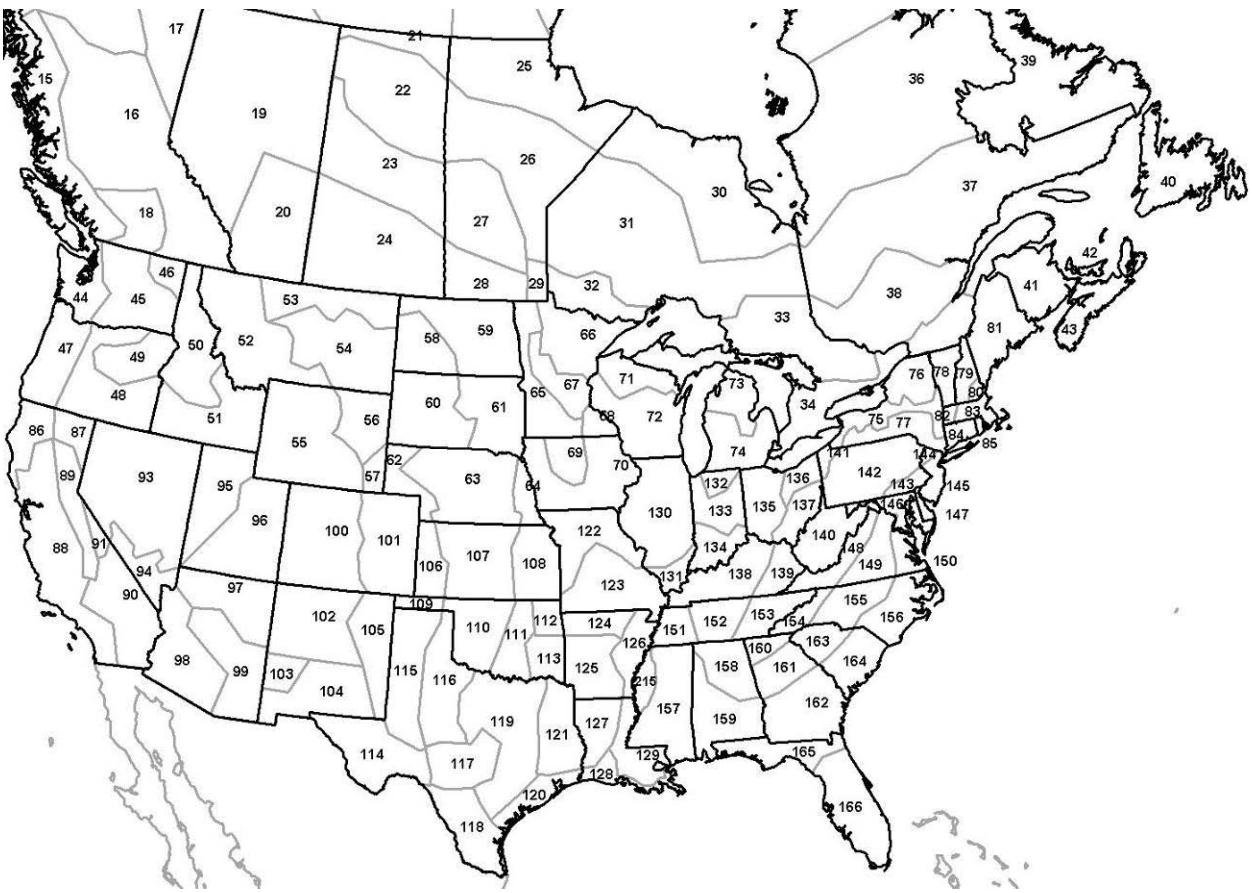
The sampling frame

In contrast to many survey programs in which survey locations are distributed evenly or randomly across the landscape without regard to habitat, a marsh bird monitoring program requires that marsh habitat be identified so that survey locations can be placed in suitable habitat. Thus, a sampling frame that identifies areas within which marsh habitat occurs is needed. The proposed sampling frame is hierarchical and includes the following "levels":

Level One: Bird Conservation Sub-region (BCS)
Level Two: Stratum within a BCS
Level Three: Site within a stratum
Additional levels as needed

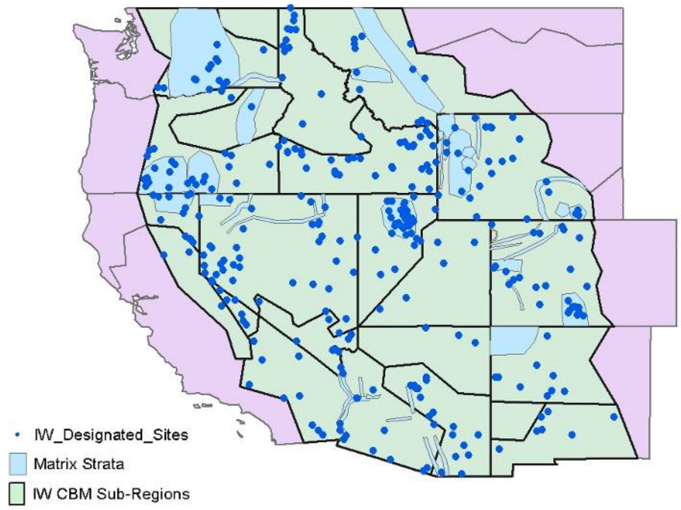
BCSs were defined throughout Canada and the U. S. by intersecting a Bird Conservation Regions (BCR) map with a map of Provinces and States (Fig. 1, Appendix A). We deleted small polygons and smoothed the BCR boundaries to make them easier to locate on the ground. The resulting 119 BCSs permit aggregating results to either the BCR or Province and State level and to any larger level that uses these sub-divisions.

Fig. 1. Proposed monitoring regions for the North American marsh bird monitoring program.



Within each BCS, two or more strata were delineated. Stratum 1 consisted of "designated sites," sites that support significant numbers of aquatic birds and that would probably be surveyed in a comprehensive aquatic bird survey. Examples include National Wildlife Refuges, State Game management areas if biologists are available to survey them, and other areas that support significant numbers of aquatic birds and that volunteers could probably be found to survey. Designated sites were numbered sequentially within each BCS. The rest of each BCS was referred to as the matrix. It was sometimes divided into 2 or more "matrix strata". For example, one part of the matrix might support numerous aquatic species whereas the rest of it might have very few aquatic species. These two regions would probably be distinguished as two separate matrix strata. If the matrix stratum consisted of well-defined sites, such as reservoirs or other water bodies, they might be numbered sequentially to facilitate development of a sampling plan for the stratum. The distinction between designated sites and individually-numbered sites in a matrix stratum is that all designated sites will be surveyed whereas only a (random) sample of the sites in matrix strata will be surveyed. Fig. 2 provides an example of designated sites and matrix strata. We attempted to identify all major sites for any aquatic species, so that we would have a comprehensive list and not have to refine it as sampling plans are developed for other groups of aquatic birds.

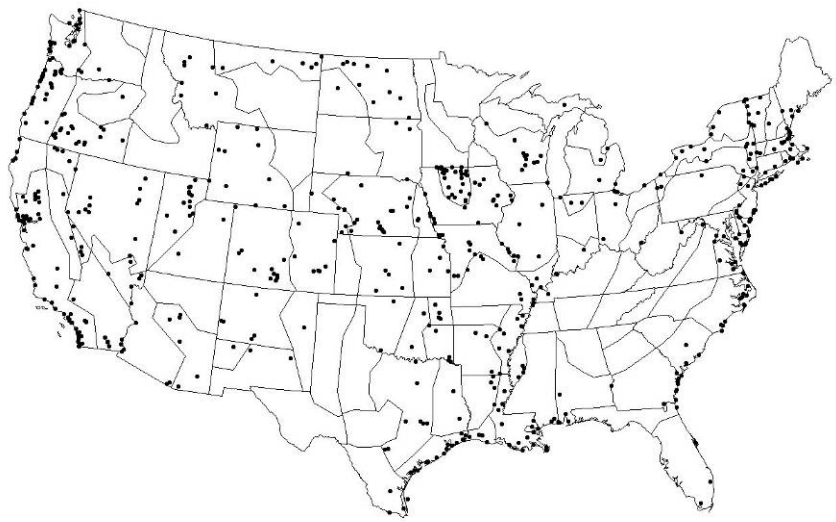
Fig. 2. BCSs, designated sites, and matrix strata in the US Intermountain West.



A separate report identifying designated sites and matrix strata was prepared for each State except Alaska and Hawaii. These reports also identify the aquatic species considered important within each BCS. In preparing each report, we contacted biologists within the State, explained the procedures, and asked for their assistance in identifying designated sites and matrix strata. We also asked them to identify which sites were of particular importance for two groups of high interest: secretive marsh birds and migrating shorebirds. The experts reviewed the reports before they were considered complete. These reports identify 1984 designated sites and several dozen matrix strata. Appendix B provides a sample report. All of the reports, and an Excel spreadsheet with all of the sites and all of the species lists, are available at http://greatbasin.nbii.gov/marshbird_docs.htm.

These reports, and the Excel spreadsheet listing all sites and the groups of birds they are most important for, can be used display sites of a particular kind. For example, Fig. 3 displays the sites judged to be most important for secretive marsh birds during the breeding season.

Fig. 3. Designated sites with significant populations of breeding secretive marsh birds



Site monitoring plans

The approach suggested here is to prepare a "site description" for each designated site and matrix stratum which provides general information about the site or stratum useful in preparing the specific surveys. The site description is followed by detailed descriptions of how to carry out each survey at the site. For example, at the Boise River designated site in Idaho, the State conducts a secretive marsh bird survey, a survey of the great blue heron rookery, and a general water bird survey. Their "Boise River Monitoring Plan" (in prep.) has the following sections: site description, secretive marsh bird survey, great blue heron rookery survey, waterbirds survey. Below, guidelines are provided for preparing the site description and designing and describing the marsh bird surveys.

Site descriptions

Overview

Survey methods for birds in aquatic sites must usually be designed using detailed information about possible change in habitat, visibility problems, access issues, and the species likely to be encountered. Detailed procedures for preparing site descriptions have been developed. Maps of each site are prepared and information useful in designing surveys for the focal species is presented using the following headings:

1. Boundaries and ownership
2. Focal species using the site and timing of use
3. Location of type 1 (good) and 2 (fair) habitat within the site
4. Access to type 1 and 2 habitat and visibility of the birds
5. Past and current surveys

6. Potential survey methods
    a. Description
    b. Selection bias
    c. Measurement error and bias
7. Needed pilot studies

Up to three types of habitats are described for each focal species or group of focal species at each site. Type 1 habitats include the regularly-used areas that should be sampled using a well-defined sampling plan. Type 2 habitats include areas used sparingly by the focal species. Type 2 habitat will not be surveyed as often or with rigorously defined methods, but will be surveyed less formally every few years to document continued low use by the focal species. Type 3 habitats (all other areas within the site) receive virtually no use by the focal species during the study period and will not be surveyed as part of the monitoring program.

Site descriptions have been prepared for most or all designated sites in Nevada, Idaho, Montana, Utah, Colorado, and are being prepared for several other States particularly in the northeast US and the Intermountain West. Most of the descriptions were incorporated into State "Coordinated Bird Monitoring Plans" which contain descriptions of the major monitoring efforts and proposed new programs as well as the site descriptions. All of them are accessible at http://greatbasin.nbii.gov/marshbird_docs.htm.

Detailed description of contents

1. Boundaries and ownership – This is a brief description of who owns the land. If special permission or permits are needed to access the site, note this. Include local contact names and phone numbers, if appropriate. Briefly describe the habitat at the site.

2. Focal species using the site and timing of use – Identify which of the focal species are found at the site. Observers should record information regarding the timing or season of use (e.g., spring migration) and estimated numbers of birds using the site, if known.

3. Location of Type 1 and 2 habitat within the site - Describe Type 1 and Type 2 habitat boundaries within the site. It may be useful to group species into functional groups (e.g., migrating shorebirds, secretive marsh birds).

4. Access to Type 1 and 2 habitat and the visibility of the birds – Describe access to the site, including observation points, boat access and permission requirements. If complete access is possible, note this. Describe problems with seeing all birds during a survey, if any. If visibility is different for different species note this (e.g., large waders are easily detected, but distances are too great to accurately identify small shorebirds).

5. Past and current surveys – Briefly describe past or current surveys at the site. Provide survey means, if available; however, do not spend a lot of time analyzing the data.

6a. Potential survey methods: description – Discuss the survey methods appropriate for each species or functional group at the site and recommend the best method(s). Consider access, visibility and past survey results in your recommendation. Consider differences in survey methods among seasons, if appropriate. Bear in mind, however, that the final decision regarding the season for monitoring will be made at a larger scale. Consider when during the day surveys should be conducted. In general, all surveys in a site should be made during a single period. Timing of surveys is especially important at tidal sites but may be important at other sites due to the sun or other factors. Note that if the number of birds present varies rapidly, as is often the case with tidal areas, then the survey period should be brief. Otherwise, surveyors may gradually learn when surveys will yield the highest counts and may be tempted to visit at these times.

6b. Potential survey methods: selection bias – Discuss the potential for selection bias in the proposed survey methods. If the entire site can be surveyed completely, there is no selection bias and “not applicable” can be entered. If only a portion of the site can be sampled, discuss reasons why the accessible area may not be representative of the total site. Provide recommendations for minimizing potential selection bias.

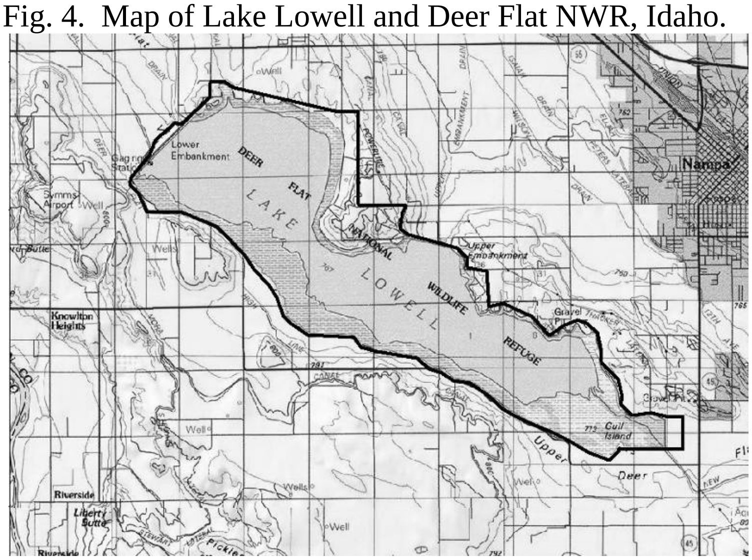
6c. Potential survey methods: measurement error and bias – Discuss the potential for measurement error and bias in your proposed survey methods. If most of the birds present at the time of the survey are counted, then measurement error and bias will be minimal. If many birds may be missed because of poor visibility or access problems, then measurement error and bias are important considerations. Discuss ways to minimize error and/or bias, if known.

7. Needed Pilot Studies – Identify what information is needed before a sampling plan could be devised for the site. If all the information requested above is available, then a pilot study is not needed for the site.

Examples

1. Lake Lowell – Deer Flat NWR, Idaho

Fig. 4. Map of Lake Lowell and Deer Flat NWR, Idaho.



Boundaries and ownership: This site encompasses Lake Lowell and the surrounding shoreline inside Deer Flat National Wildlife Refuge. It is administered by the USFWS. Habitats include open water in the middle of the lake and marsh along the sides of the lake. Open mudflats are found primarily at the SE end of the lake and the NE lower embankment when the lake water level is low. Contacts: Greg Kaltenecker, Idaho Bird Observatory, 208-377-1440 or Refuge Manager, 208-467-9278

Focal species: Most aquatic focal species are found at this site.

Location of Type 1 and Type 2 habitat: Location of birds varies with the water level and season.

Table 1. Definition of type 1 and 2 habitat for Lake Lowell-Deer Flat NWR, Idaho.

Functional Group	Type 1 Habitat	Type 2 Habitat
waterbirds	open water & emergent vegetation	none
large waders	breeding colonies, emergent vegetation	rest of shoreline
secretive marsh birds	water's edge, except during very low water	none
waterfowl	open water, edges during breeding season	none
shorebirds	exposed mudflats at SE tip & at NW lower embankment during spring/fall migration	rest of shoreline
gulls and terns	all areas	none

Access to Type 1 and Type 2 habitat and visibility of the birds: Open water can be accessed by boat and marshes can be accessed by canoe. There are seven access points from the roads and there is a patrol road along the SE side of the Lake. Visibility is good for open water or exposed mudflat counts by boat or from access points. Visibility is poorer in emergent vegetation but can be improved by using a canoe for access.

Past and current surveys: Refuge staff conduct mid-winter waterfowl counts by small plane. Idaho Bird Observatory conducts Bald Eagle nesting surveys (mean = 2 nests/year) and colony counts for Great Blue Herons (mean = 20-25 nests/year).

Potential survey methods, description:

a. Nest searches for grebes and other waterbirds nesting in the emergent vegetation in small colonies. A canoe is necessary for access.
b. Colony counts for nesting Great Blue Herons and Double Crested Cormorants
c. Census for waterfowl on the open water using a boat. Late summer or winter counts may be better than breeding season counts, as waterfowl are more easily detected during this period.
d. Area searches for migrating shorebirds from observation points near Type 1 habitat.
e. Systematic sample, probably including the use of playback calls, for secretive marsh birds using a canoe to access marshes
f. Census gulls and terns during waterfowl counts?

Potential survey methods, selection bias: Not applicable unless a systematic sampling approach is taken for the secretive marsh birds.

Potential survey methods, measurement error and bias:

a. Error and bias are negligible for nest searches and colony counts

b. Error and bias are probably negligible for area searches for migrating shorebirds, although this needs field verification

c. Error and bias are negligible for waterfowl counts in late summer or winter, but could be relatively high during the breeding season because of cryptic nesting birds

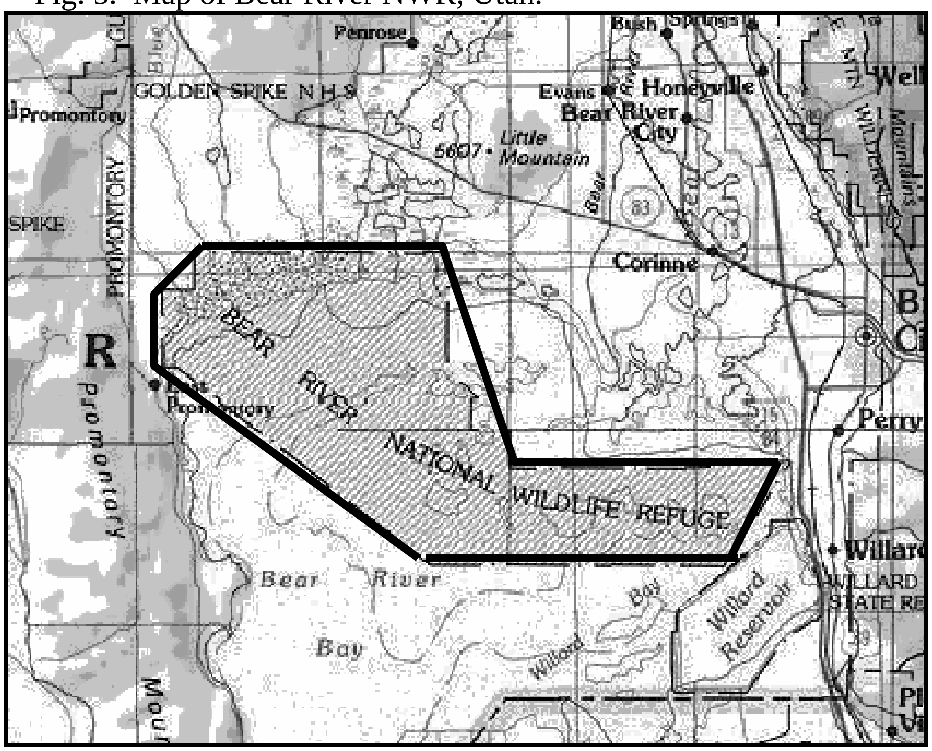
d. Error and bias are unknown for secretive marsh birds

e. Error and bias are negligible for gulls and terns if a census is possible.

Needed pilot studies:
Few needed. This is a good site to test protocols for groups of species. A site visit is recommended to assess the error associated with making counts from observation points for migrating shorebirds.

2. Bear River NWR, Utah (shorebirds only)

Fig. 5. Map of Bear River NWR, Utah.



Boundaries and Ownership: This site is the entire NWR and is administered by the U.S. Fish and Wildlife Service. Bear River NWR is a large, important area for shorebirds; however the habitat changes dramatically due to management regimes and flood events that remove vegetation.

Focal species and timing: Most shorebird focal species in Utah use this site during spring and/or fall migration. Species include: AMAV, BNST, GRYE, LEYE, MAGO, LBDO, WESA, WIPH.

Location of Type 1 and 2 habitat: Much of the refuge is Type 1 habitat during some years or seasons, although there may be areas of Type 2 or 3 habitats. More work is needed to identify all Type 1 habitats.

Access to Type 1 and 2 habitat and visibility of birds: Visibility is often low and access to all areas of the refuge is questionable.

Past and current surveys: This area was surveyed on the Great Salt Lake Water bird Survey (areas 27, 29a, and 29b). Area 29b was along the refuge road and had low numbers (<10) of focal species. Means/survey (>10) for focal species for areas 27 and 29a were WIPH – 3684, WESA – 4619, LBDO – 3510, MAGO – 4938, GRYE – 11, and LEYE – 12. Tens of thousands of AMAV and thousands of BNST were also counted.

Potential survey method, description: Potential survey methods cannot be determined until the location and extent of all type 1 habitat is identified and the issues of visibility and access are addressed.

Potential survey method, selection bias: If all of the Type 1 habitat on the Refuge cannot be accessed, the potential for selection bias exists. Selection bias could be minimized if a sampling plan is implemented where a small, random sample of the inaccessible Type 1 habitat is surveyed each year.

Potential survey method, measurement error and bias: The potential for measurement error and bias exists in those areas where visibility is poor. A double sampling approach to estimate detection rates may be appropriate for assessing measurement error.

Needed pilot studies: A pilot study is needed to classify all areas in the site as Type 1, 2 or 3 habitats and to assess whether there are Type 1 areas that are inaccessible. If all Type 1 habitats cannot be accessed, then a small, random sample of the inaccessible Type 1 habitat should be surveyed each year. The ability of observers to count all birds present, even in areas of low visibility, needs to be assessed. A double sampling approach would provide this information.

Design of site-specific sampling plans

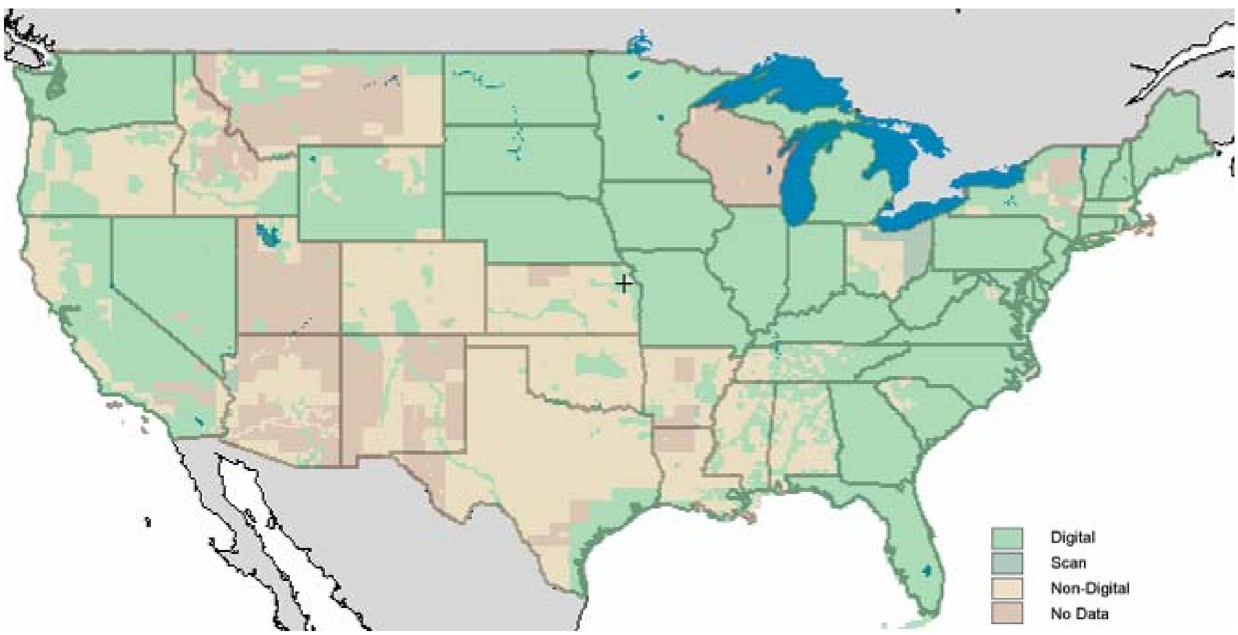
Once designated sites, for a given survey, are identified, decisions must be made about which areas within the site will be surveyed. In many sites, all accessible areas are covered on general aquatic bird surveys. Some areas (e.g., many coastal marshes), however, are too large to survey completely so sampling is needed. In addition, surveys for secretive marsh birds involve selection of locations at which the point counts are conducted. This section discusses ways to select survey areas or points.

Mapping suitable habitat

The first step is to prepare a map of the site or matrix stratum showing the areas in which any of the focal species are believed to be present, in non-negligible numbers, during the survey season. Many sources may be used to delineate suitable habitat. The most comprehensive one, in the United States, is the National Wetlands Inventory (NWI; http://wetlandsfws.er.usgs.gov/) which covers much, though by no means all, of the 48 contiguous States (Fig. 6). Their "Wetlands Mapper" may be used to display the NWI (and other) data for any site they have mapped, and a pdf file can be downloaded. The Mapper is slow, however, and a better option is probably to download their digital data and use a GIS to create the map.

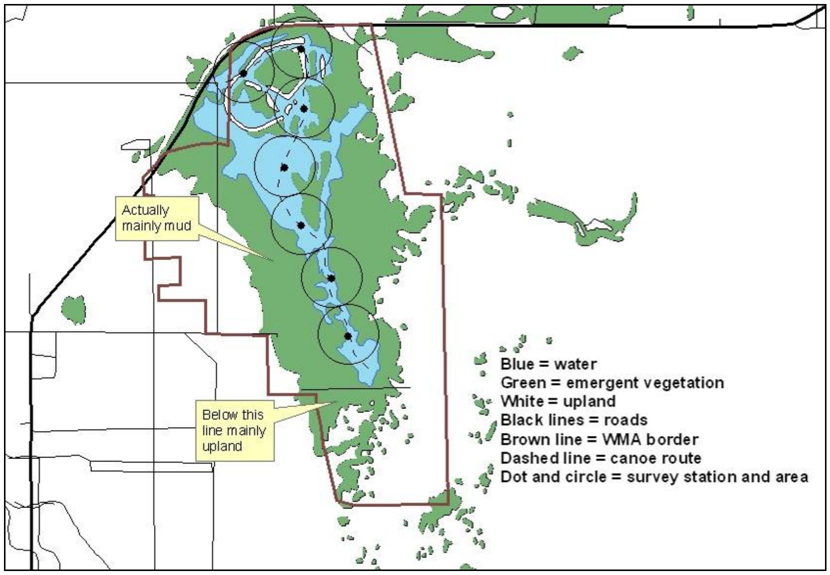
While the NWI maps are of great value, they are several years old in many regions and changes may have occurred in the distribution of suitable habitat since they were prepared. Also, suitable habitat for marsh birds may move around and preparing new maps each year may be worthwhile. Other sources thus often must be used. Aerial photos and satellite imagery, including sources now available on the internet (e.g., Google Earth™), may be useful. State agencies may also have useful images. For example, in Idaho images from the Tax Bureau are being used (C. Moulton, pers. comm.). There is no need to standardize vegetation categories or even map accuracy across regions. The goal at this stage is simply to show the distribution of suitable habitat.

Fig. 6. Areas mapped by the National Wetlands Inventory



The next step is to decide which locations are suitable for conducting surveys and to distribute survey locations evenly across this area. For the secretive marsh bird protocol, this means identifying locations at which the survey could be conducted. In many sites, these locations are restricted to dikes, roads, marsh edges and other linear features. Carey Lake WMA in Idaho (Fig. 7) provides an example. The area was depicted on NWI imagery as having a lake in the center of the site, but this area is now covered by dense emergent vegetation, and only a narrow channel, accessible by canoe, is available to surveyors. Thus survey locations were restricted to this channel.

Fig. 7. The Carey Lake WMA designated site.



At other sites, habitat may occur in patches and placing survey locations within these patches may be worthwhile. The Sterling WMA in Idaho (Fig. 8) provides an example. Habitat in this WMA is more open than in the Carey WMA, and surveyors can reach any point within it. The habitat is quite variable between years, however, so it was decided to make a new map each year, using aerial photographs or reconnaissance on the ground, and to distribute the count locations so that they covered the habitat as thoroughly as possible. Fig. 8 shows how survey locations might be distributed if habitat occurred as depicted on the NWI imagery.

Fig. 8. Sterling WMA, Idaho (color scheme is the same as in Fig. 7).

In larger sites the surveyed area may cover a much smaller portion of the area accessible to surveyors. In such cases, using a well-defined sampling plan to select locations may be useful, though an alternative is just to distribute the survey locations, or survey routes, evenly across the site. Any well-defined sampling plan may be used to select survey locations. Simple plans are generally sufficient. Three issues are discussed below. Consulting a statistician for advice on design of the sampling plan is recommended, especially for cases not covered by the following brief discussion.

A first issue is whether to sub-divide the sampled population into strata. Strata may be delineated so that sampling intensity can vary between strata, so that separate estimates can be computed for each stratum, or because different sampling plans will be used in different strata. Many refuges are subdivided into impoundments or other units which make natural strata and ensures that separate estimates will be available for each unit. The strata should partition the suitable habitat, i.e., every point in suitable habitat should be in exactly one stratum.

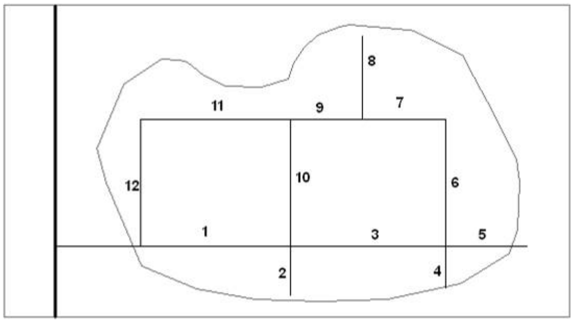
A second issue is whether to use cluster sampling. Cluster sampling occurs when a set of locations is selected and then a cluster of survey plots or points is selected at each location. The BBS is a typical example. Starting locations for survey routes are selected randomly and then a cluster of 50 locations is selected in the vicinity of each location. Cluster sampling usually yields less precise estimates than a one-stage sample of the same size. This approach should therefore be used primarily in cases where distributing locations evenly across the site or stratum will lead to large travel costs with a resulting decrease in sample size or increase in project costs.

In selecting the survey locations or clusters of locations, systematic selection seems preferable to simple random selection to insure that the area is covered evenly. As a practical matter, selection can probably be made non-randomly by distributing the plots or points evenly (subject to a minimum nearest neighbor distance for point counts) across the area without reference to habitat quality (so “good” locations will be neither favored nor avoided). Two more formal methods are described below however. They may be useful when the sampled area is large relative to the area surveyed and when suitable habitat is patchy.

In method one (Fig. 9) we assume that survey locations are restricted to dikes, roads, wetland edges or other linear features and a series of locations for point counts is needed. Assume that the minimum distance between points is to be 0.4 km. A simple approach for selecting survey locations is to number the segments sequentially, determine the length (in km) of each segment, and add these lengths to get the total length. Divide the total length by the number of stations that can be surveyed to get the distance, D say, between stations. Then randomly select a location within the interval 1 to D and place the first station at this distance from the start of the first segment. If the suitable habitat begins at the beginning of this segment, it may be worth selecting a location between 0.2 and D to keep the surveyor at least 0.2 km (the half width of the survey circle) from the edge of the habitat. Place subsequent stations at intervals of D or more if needed to keep circles from over-lapping.

Fig. 9. Hypothetical area showing placement of survey locations using "Method One" (see text).

A. Segments



B. Segment lengths

Segment	Length (km)	Segment	Length (km)
1	5.0	7	2.8
2	2.1	8	4.1
3	5.0	9	2.2
4	2.0	10	5.0
5	2.7	11	5.0
6	5.0	12	5.0

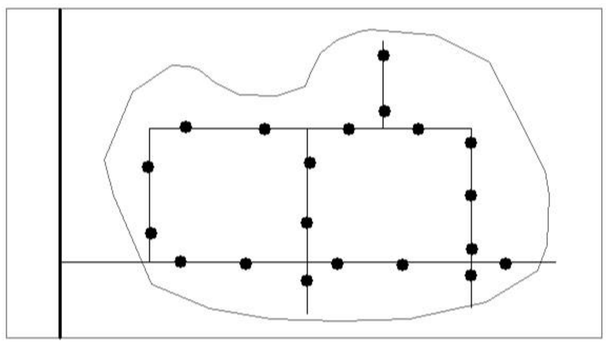
C. Calculations for interval and starting point

Total length	45.9	Distance between stations	2.3
N stations	20	Random start	0.8

D. Calculations for starting points

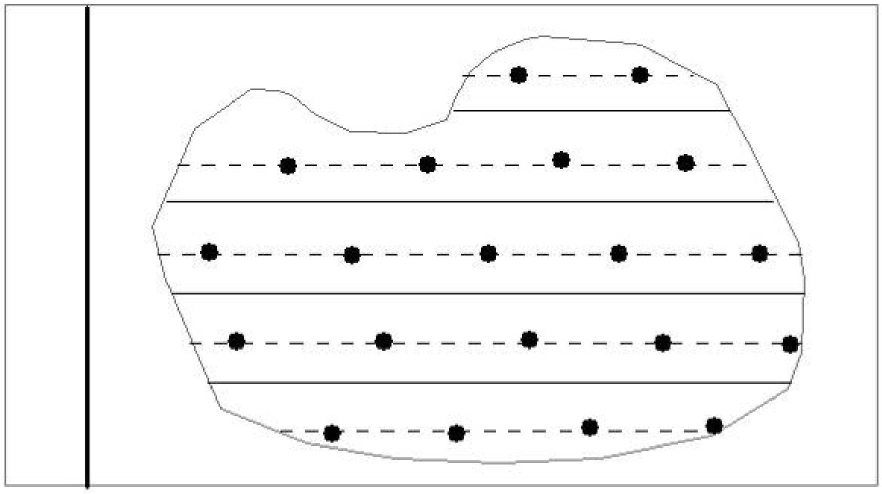
Stn.	Seg.	Pos'n	Stn.	Seg.	Pos'n
1	1	0.8	11	7	2
2	1	3.1	12	8	1.5
3	2	0.4	13	8	3.8
4	3	0.6	14	9	2
5	3	2.9	15	10	2.1
6	4	0.2	16	10	4.4
7	5	0.5	17	11	1.4
8	6	0.1	18	11	3.7
9	6	2.4	19	12	1
10	6	4.7	20	12	3.3

D. Survey locations



In method two (Fig. 10) we assume that all parts of the sampled population may be reached by surveyors. A simple approach in such cases is to partition the area into bands, randomly select a point between the two bands and then establish parallel lines at this point. These lines can then be treated as the "segments" in the approach described immediately above, and the same process can be followed to select the points. The needed distance between survey stations and survey lines is the square root of A/n where A=area and n = the number of stations. An alternative to this approach is to use a GIS routine to randomly select points, but with the restriction that they be no closer together than 0.4 km. As noted above, however, this approach can result in considerable clumping of points and large areas with few or no survey points. The systematic approach described above avoids this problem.

Fig. 10. Example of "Method Two" for selecting survey point locations (see text). Only the final result is shown.



In many sites, some areas will be difficult or impractical to reach. If they are impractical to reach they are just excluded from the sampled area. If they are only difficult to reach, then some consideration may be given to assigning them to a separate stratum and sampling that stratum at low intensity.

A final question is how to select times for the survey when points are surveyed more than once. Recommendations vary on whether to survey in the same order each time or vary the order. Rotating times, as is usually done in point count studies of terrestrial systems, has the advantage of covering the statistical population (all places at all times) more evenly and of facilitating within-site comparisons because contrasts are more likely to be balanced with respect to survey times. This approach, however, may be more difficult to schedule than simply repeating the route in the same order each time. Whatever approach is followed it should be well documented so future surveyors can continue the same method.

Methods for matrix strata

Less experience has been accumulated with sampling plans for matrix strata than with designated sites so guidelines at present are tentative. Two broad approaches may be distinguished however. The first approach applies when suitable habitat is concentrated in a relatively small number of sites such as lakes and reservoirs. They may be too numerous for surveyors to visit all of them, but it still may be feasible to enumerate them. A random or systematic sample of the desired size may then be selected and the sampling plan for selected units may be developed following the guidelines above.

When suitable habitat is too extensive and patchy to enumerate or delineate then the best approach is probably to delineate large areas such as blocks 20 km on a side or townships. A systematic sample of these areas may then be selected. Within the selected units, the guidelines above may be followed. Often, stratification and/or cluster sampling will be useful. Skagan and Bart (2005) followed this approach in designing surveys for migrant shorebirds in the Dakotas.

A systematic sample of townships was selected and then one driving route was randomly selected in each selected township. All suitable habitat within 200 m of the road, along the route, was surveyed. In a survey for secretive marsh birds, the habitat along the route might first be mapped and then a systematic sample of points, at which counts would be made, would be selected within suitable habitat. If the habitat was too patchy to map, then the sample of points might be selected without first delineating suitable habitat. This would cause some points to be in non-suitable habitat, but 0s would just be entered for these locations and the surveyor could pass immediately to the next point so little time would be lost. The main disadvantage of this approach, compared to delineating suitable habitat, is that the within-cluster variance would be high due to numerous 0s.

BCS 51, southern Idaho, provides an example of the methods discussed above. Stratum 1 includes 36 designated sites (Appendix B) about half of which have been surveyed. The rest will be surveyed during the next several years. A new sampling plan will then be developed with lower sampling intensity. This may be accomplished by assigning many of the sites to matrix strata and then selecting a sample of them for coverage. Alternatively, they may all be retained as designated sites but only be surveyed every 2-3 years. In the matrix, 37 lakes >300 acres have identified and could be assigned to one stratum. A sample of them could then be selected for surveys. NWI data is available for only a part of this BCS but it, along with other information, can probably be used to delineate strata with more and less wetlands. For example, the southwest portion (Owyhee uplands) has very few wetlands whereas the eastern portion has more wetlands. It thus might be reasonable to delineate "high" and "low" density sampling units (e.g., townships). The matrix would thus be partitioned into three strata: lakes >300 acres, high density units, low density units. A sample from each stratum would then be selected and surveyed. Selected units might be further stratified so that efforts were concentrated in the better areas. Surveys might be along randomly selected driving routes.

Describing the sampling plan

The plan used to select survey locations at each site should be documented and information needed to aggregate results across sites (see next section) should be recorded. The information needed is:

1. Map showing site and survey locations
2. BCS
3. Site number and name
4. Years that the information applies to
5. Area of the target population within the site
6. Description of survey locations
    a. Stratum and/or cluster if applicable
    b. Latitude and longitude
    c. Area of the survey circle covered by the target population
7. Advice on conducting the survey

An example is shown in Fig. 11.

Fig. 11. Example of the data needed for each site.

A. Site description

Bird Conservation Sub-region	51
Number	3
Name	Smith Falls
Area of target population (km^2)	65

B. Survey locations

Cluster	Number	Latitude	Longitude	Area Circle	Prop. in the target population	Area in the target population
1	1	48.9503	-116.5512	0.50	1.0	0.50
1	2	48.9512	-116.5480	0.50	1.0	0.50
1	3	48.9537	-116.5453	0.50	0.5	0.25
2	1	48.9561	-116.5422	0.50	0.1	0.05
2	2	48.9573	-116.5395	0.50	0.8	0.40
2	3	48.9588	-116.5362	0.50	1.0	0.50

C. Notes on conducting the survey

Aggregating results across sites

This section discusses information that will be needed for statistical analysis of the marsh bird survey data and how it might best be organized. As noted in another report (Bart 2006), results from the marsh bird survey will be used to address a wide variety of management issues including identifying species at risk, setting harvest rates, designing and evaluating management programs, and carrying out local projects. All but the last of these will require aggregating results across sites. Many different ways exist to aggregate the data, and in some cases they require different information. In designing the approach for storing information about each level in the sampling plan, it seems wisest to provide an opportunity to store any information that might be useful.

A brief description of terminology may be helpful. At any given scale, the *target population* comprises the areas that we would ideally like to be able to include in the survey. Some portions of the target population may be inaccessible; the *sampled population* is that portion of the target population which can feasibly be surveyed. *Partitioning* means sub-dividing the population or any specified portion of it into compartments so that every point is in exactly one compartment. The sampling plan consists of a series of *levels* at each of which the population or a portion of it is partitioned into *sampling units* or, at the final level, *plots*. The compartments produced when a given sampling unit is partitioned are often referred to as the sub-units for the level. The population units are defined in time as well as space. Thus a survey is made at a given location at a given time. A survey at the same place but at a different time may record different birds. Levels thus may refer to partitioning time rather than space. In the secretive marsh bird survey, assuming >1 survey/year and allowing the possibility of >1 survey per day, the minimum number of levels is:

1. BSC
2. Stratum (designated site or matrix stratum)
3. Site
4. Plot
5. Year
6. Day (julian)
7. Start time

The series of numbers identifying the position of a given survey in the population may be referred to as the survey's *pedigree*. If the site was sub-divided into strata (e.g., impoundments) and then into clusters of locations, then the surveys would have a 9-level, rather than a 7-level, pedigree. The importance of the pedigree is that aggregating results across levels (e.g., to compute the mean numbers recorded/plot in a State) requires that proper weights be used. The definition of the weights depends on the estimation method used. For levels at which space is sub-divided, the weights are either the number of sub-units or the total amount of area in the target population in all the sub-levels. The number of sub-units is usually known or can be calculated. The total area often is not known, in which case some estimators cannot be used. For levels at which time is sub-divided, the weights are the numbers of sub-units or simple functions of these numbers. Thus, at each level (except the last), it is feasible and necessary to record the number of sub-units and it is desirable to record the total area (of target population) in all the sub-units.

Because the sampling plans differ among sites, a given entity, such as an impoundment may occur at different levels in different sites. It is therefore helpful to record, for each sampling unit, a "type" and "name". This allows users to extract data for any specified set of units (e.g., sites, impoundments, or plots).

To illustrate how the data might be stored, consider a simple example. Suppose that designated site 13 in BCS 47 has two strata and 2 plots in each stratum. Suppose further that in 2006 each plot was surveyed twice and the sampling plan called for at most one survey per day (so there is no need to define start time as a level). The needed information for the surveys at this site in 2006 might then be stored as in Fig. 12.

Fig. 12. Information needed about the surveys in 2006 at a small, hypothetical site.

Row	1	2	3	4	5	6	7	Type	Name	Sub-levels	Area
1	47	1	13					Site	Mud Lake	2	-1
2	47	1	13	1				Stratum	East	54	-1
3	47	1	13	1	1			Plot	1	0	0.5
4	47	1	13	1	1	2006		Year	2006	30	-1
5	47	1	13	1	1	2006	1	Day	153	0	-1
6	47	1	13	1	1	2006	2	Day	165	0	-1
7	47	1	13	1	2			Plot	2	0	0.5
8	47	1	13	1	2	2006		Year	2006	30	-1
9	47	1	13	1	2	2006	1	Day	153	0	-1
10	47	1	13	1	2	2006	2	Day	165	0	-1
11	47	1	13	2				Stratum	West	113	-1
12	47	1	13	2	1			Plot	1	0	0.5
13	47	1	13	2	1	2006		Year	2006	30	-1
14	47	1	13	2	1	2006	1	Day	153	0	-1
15	47	1	13	2	1	2006	2	Day	165	0	-1
16	47	1	13	2	2			Plot	2	0	0.25
17	47	1	13	2	2	2006		Year	2006	30	-1
18	47	1	13	2	2	2006	1	Day	153	0	-1
19	47	1	13	2	2	2006	2	Day	165	0	-1

The first column, row, is not needed in the database but is included for ease of reference here. The first three columns report the BSC (47), the strata (1=designated sites), and the site number (13). Row 1 tells us that the sampling unit is a site and provides the name. this row also indicates that the site is partitioned into 2 sub-units, the strata "East" and "West", and the area of target population within the entire site is unknown. Row 2 indicates that the east stratum has 54 times as much target area as is covered by one point count circle. From row 11, the corresponding number for the west stratum is 113. Row 3 gives the pedigree for plot 1 in stratum 1 and indicates that all of the circle is in the target population. Row 4 indicates that the number of sub-levels (days) that 2006 is sub-divided into equals 30. The next two rows identify the day on which each of the two surveys was made and give the full pedigree for these surveys. Rows 7-10 give the corresponding information for plot 2 in stratum one. Rows 11-19 give similar information for stratum 2. (*Note: I still need to work on auxiliary information needed for temporal levels.*) In practice, several additional columns would be included for additional levels that sampling plans might have.

As noted above, many different estimators exist for multiple level data, especially when units vary in size at every level as is true in the marsh bird monitoring program. It may be helpful, however, to present one such estimator. Density, or relative density (if detection rates are unknown), may be estimated using a "ratio of means" approach (Cochran 1977) as follows. The example is for a four-level plan but generalizes easily to any number of levels. Let y_{ijkl} = the number of birds recorded on the l^{th} plot of the k^{th} 3rd-level unit, of the j^{th} 2nd-level unit, of the i^{th} 1st-level unit. Let a_{ijkl} = the area of the plot. Density is estimated as

$$d = \frac{\hat{Y}}{a} = \frac{estimated\ number\ of\ birds}{estimated\ area\ based\ on\ units\ in\ the\ sample}\ . \tag{1}$$

The rationale for this estimator is that if, by chance, the units in the sample are smaller than average, then the number of birds recorded will also probably be smaller than average, but the ratio above may be about right. $\hat{Y}$ and a are calculated as

$$\hat{Y} = \frac{N}{n}\sum_{i}^{n}\frac{N_i}{n_i}\sum_{j}^{n_i}\frac{N_{ij}}{n_{ij}}\sum_{k}^{n_{ij}}\frac{N_{ijk}}{n_{ijk}}\sum_{l}^{n_{ijk}}y_{ijkl} \tag{2}$$

$$a = \frac{N}{n}\sum_{i}^{n}\frac{N_i}{n_i}\sum_{j}^{n_i}\frac{N_{ij}}{n_{ij}}\sum_{k}^{n_{ij}}\frac{N_{ijk}}{n_{ijk}}\sum_{l}^{n_{ijk}}a_{ijkl} \tag{3}$$

where $n_.$ and $N_.$ are the numbers of units in the sample and population respectively. For example, n = the number of 1st level units in the sample and N_{ijk} = the number of 3rd level units in the j^{th} 2nd level unit of the i^{th} 1st level unit. The variance of this estimator may be derived using methods in Cochran (1977).

The general approach for calculating expression (1) would be

1. The user specifies values for the sampling units at each level and for the species to be analyze.

2. A filtering program is executed which deletes data outside the specified ranges but otherwise does not change the data.

3. An analysis program is run on the reduced data set.

With this approach, users can specify a wide variety of analyses and a single program can be used to carry them out, even though the sampling plans differ widely among sites. For example, a user might ask for the density, for a specified group of species, across all sites in 5 States (by enumerating the BSCs) during the 1990s.

Implications for data base design

The data base for the marsh bird monitoring program is being designed by others, but a few implications of the approach suggested above for designing the sampling plan and recording information about the sampling units may be worth mentioning.

1. As indicated by expression (1), it is essential that provision be made to record the “size” (number of sub-units or area) of each sampling unit at each level. Without that information, there will be no appropriate way to combine intermediate results (e.g., means per impoundment, site or BSC).

2. It must be possible to calculate the “finite population corrections” at each stage. They will often be 1 which reduces the variance at that stage to 0. Recording the number of sub-units in each sampling unit, and letting the analysis program calculate the number of these in which surveys were conducted, provides the needed information.

3. The data base will be *far* more powerful if it is feasible to extract sub sets of the data based on ecological, or other, characteristics. This is one of the reasons for including a “Type” and “Name” column in the table above. Separate tables can be provided giving characteristics of units of particular interest. For example, sites might be characterized by the broad ecological zone they are in, and then the user might ask for data for all sites in a given zone. Alternatively, the elevation or habitat for each plot might be recorded and users might select plots using those variables. This suggests the value of a series of tables providing this kind of information for various sampling units.

4. I doubt that trend estimation can be accomplished for the marsh bird monitoring data using existing methods due to the complex pedigrees for each survey and the fact that suitable habitat moves around in many regions so “route regression” methods are unlikely to work without substantial modification. A more general approach may be preferable, but I have been reluctant to suggest one. I believe the next step will be for the group to jointly agree on a process for developing trend estimation methods for the marsh bird monitoring data.

Next steps

In addition to review and discussion of the recommendations in this report, the steps that seem most important to me are as follows:

1. Gain more experience with designing sampling plans for large designated sites, designated sites in coastal areas, and sites in the matrix. Although I have studied several dozen sites during the past 4 years, while developing these recommendations, I still have very limited experience with the groups above.

2. Agree on the data base design. I have hired a programmer to prepare such a data base for the Intermountain West CBM program.

3. Agree on a small set of basic estimators (e.g., for plotting distribution and abundance, calculating density, investigating environmental relationships, and estimating trends). Prepare programs to carry out these tasks.

Literature cited

Bart, J. 2006. Management issues to be addressed by the North American marsh bird monitoring program. Unpublished manuscript available at http://greatbasin.nbii.gov/marshbird_docs.htm

Cochran, W. G. 1977. Sampling techniques, 3d edition. J. Wiley Sons, New York, New York, USA.

Francis, C.M. and R.C. Weeber. Statistical issues related to monitoring marsh birds. Pages 23-24 in C.A. Ribic, S. Lewis, S. Melvin, J. Bart and B. Peterjohn. 1999. Proceedings of the marsh bird monitoring workshop. USFWS Region 3 Administrative Report, Fort Snelling, Minnesota.

Ribic, C.A., S. Lewis, S. Melvin, J. Bart and B. Peterjohn. 1999. Proceedings of the marsh bird monitoring workshop. USFWS Region 3 Administrative Report, Fort Snelling, Minnesota.

Skagan, S. and J. Bart. 2005. Migration monitoring in shorebirds and landbirds: Commonalities and differences. Pp. 726-728 in C. J. Ralph and T. D. Rich, editors. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference. 2002 March 20-24; Asilomar, California; Volume 2. Gen. Tech. Rep. PSW-GTR-191. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 643 p.

Appendix A. Bird conservation sub-regions

BCS	Country	Prov/State	BCR
1	United States	Alaska	2
2	United States	Alaska	2
3	United States	Alaska	2
4	United States	Alaska	3
5	United States	Alaska	4
6	United States	Alaska	5
7	Canada	Yukon Territory	4
8	Canada	Northwest Territories	6
9	Canada	Northwest Territories	3
10	Canada	Northwest Territories	3
11	Canada	Nunavut	3
12	Canada	Northwest Territories	7
13	Canada	Northwest Territories	7
14	Canada	British Columbia	10
15	Canada	British Columbia	5
16	Canada	British Columbia	10
17	Canada	British Columbia	6
18	Canada	British Columbia	9
19	Canada	Alberta	6
20	Canada	Alberta	11
21	Canada	Saskatchewan	7
22	Canada	Saskatchewan	8
23	Canada	Saskatchewan	6
24	Canada	Saskatchewan	11
25	Canada	Manitoba	7
26	Canada	Manitoba	8
27	Canada	Manitoba	6
28	Canada	Manitoba	11
29	Canada	Manitoba	12
30	Canada	Ontario	7
31	Canada	Ontario	8
32	Canada	Ontario	12
33	Canada	Ontario	12
34	Canada	Ontario	13
35	Canada	Quebec	3
36	Canada	Quebec	7
37	Canada	Quebec	8
38	Canada	Quebec	12
39	Canada	Labrador	7
40	Canada	Newfoundland	8
41	Canada	Ontario	14
42	Canada	Prince Edward Island	14
43	Canada	Nova Scotia	14
44	United States	Washington	5
45	United States	Washington	9

BCS	Country	Prov/State	BCR
46	United States	Washington	10
47	United States	Oregon	5
48	United States	Oregon	9
49	United States	Oregon	10
50	Canada	Idaho	10
51	United States	Idaho	9
52	United States	Montana	10
53	United States	Montana	11
54	United States	Montana	17
55	United States	Wyoming	10
56	United States	Wyoming	17
57	United States	Wyoming	18
58	United States	North Dakota	17
59	United States	North Dakota	11
60	United States	South Dakota	17
61	United States	South Dakota	11
62	United States	Nebraska	18
63	United States	Nebraska	19
64	United States	Nebraska	22
65	United States	Minnesota	11
66	United States	Minnesota	12
67	United States	Minnesota	23
68	United States	Minnesota	22
69	United States	Iowa	11
70	United States	Iowa	22
71	United States	Wisconsin	12
72	United States	Wisconsin	23
73	United States	Michigan	12
74	United States	Michigan	23
75	United States	New York	13
76	United States	New York	14
77	United States	New York	28
78	United States	Vermont	14
79	United States	New Hampshire	14
80	United States	New Hampshire	30
81	United States	Maine	14
82	United States	Massachusetts	14
83	United States	Massachusetts	30
84	United States	Connecticut	30
85	United States	Rhode Island	30
86	United States	California	5
87	United States	California	9
88	United States	California	32
89	United States	California	15
90	United States	California	33

Appendix A (cont'd)

BCS	Country	Prov/State	BCR
91	United States	California	9
92	United States	Hawaii	0
93	United States	Nevada	9
94	United States	Nevada	33
95	United States	Utah	9
96	United States	Utah	16
97	United States	Arizona	16
98	United States	Arizona	33
99	United States	Arizona	34
100	United States	Colorado	16
101	United States	Colorado	18
102	United States	New Mexico	16
103	United States	New Mexico	34
104	United States	New Mexico	35
105	United States	New Mexico	18
106	United States	Kansas	18
107	United States	Kansas	19
108	United States	Kansas	22
109	United States	Oklahoma	18
110	United States	Oklahoma	19
111	United States	Oklahoma	21
112	United States	Oklahoma	22
113	United States	Oklahoma	25
114	United States	Texas	35
115	United States	Texas	18
116	United States	Texas	19
117	United States	Texas	20
118	United States	Texas	36
119	United States	Texas	21
120	United States	Texas	37
121	United States	Texas	25
122	United States	Missouri	22
123	United States	Missouri	24
124	United States	Arkansas	24
125	United States	Arkansas	25
126	United States	Arkansas	26
127	United States	Louisiana	25
128	United States	Louisiana	37
129	United States	Louisiana	26
130	United States	Illinois	22
131	United States	Illinois	24
132	United States	Indiana	23
133	United States	Indiana	22
134	United States	Indiana	24
135	United States	Ohio	22
136	United States	Ohio	13
137	United States	Ohio	28
138	United States	Kentucky	24
139	United States	Kentucky	28
140	United States	West Virginia	28
141	United States	Pennsylvania	13
142	United States	Pennsylvania	28
143	United States	Pennsylvania	29
144	United States	New Jersey	28
145	United States	New Jersey	30
146	United States	Maryland	29
147	United States	Delaware	30
148	United States	Virginia	28
149	United States	Virginia	29
150	United States	Virginia	27
151	United States	Tennessee	27
152	United States	Tennessee	28
153	United States	Tennessee	28
154	United States	North Carolina	28
155	United States	North Carolina	29
156	United States	North Carolina	27
157	United States	Mississippi	27
158	United States	Alabama	28
159	United States	Alabama	27
160	United States	Georgia	28
161	United States	Georgia	29
162	United States	Georgia	27
163	United States	South Carolina	29
164	United States	South Carolina	27
165	United States	Florida	27
166	United States	Florida	31

Appendix B. Designated sites and matrix strata in Idaho

(*Note: This report, and all the other State reports, use an older term for the BSCs, Bird Monitoring Regions.-JB*)

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June 2004

Prepared for the Coordinated Bird Monitoring project
Funded by the US Fish and Wildlife Service and the US Geological Survey

Introduction

This is one of a series of reports that summarize information about sites and regions important to aquatic birds. The report is intended to facilitate development of comprehensive surveys for aquatic birds. Similar reports have been prepared for each of the 48 coterminous States. The reports were prepared as part of the Coordinated Bird Monitoring (CBM) effort that many States and other groups are engaged in (Bart and Ralph, 2004, 3rd International PIF symposium, US Forest Service; available from J. Bart at jon_bart&usgs.gov). The work on CBM has included a substantial effort, funded by the US Fish and Wildlife Service and the US Geological Survey, to develop a sampling plan for aquatic species. The sampling frame is hierarchical and includes the following "levels":

Level One: Bird monitoring region
Level Two: Stratum within a bird monitoring region
Level Three: Specific site, plot, or area within a level-two stratum
Additional levels as needed

Bird Monitoring Regions (BMRs) were defined throughout Canada and the US by intersecting a Bird Conservation Regions (BCR) map with a Provinces and States map. We deleted small polygons and smoothed the BCR boundaries to make them easier to locate on the ground. The resulting BMRs permit aggregating results to either the BCR or Province and State level and to any larger level that uses these sub-divisions.

Within each BMR, two or more strata were delineated. Stratum 1 consists of "designated sites", sites that support significant numbers of aquatic birds and that would probably be surveyed in a comprehensive aquatic bird survey. Examples include National Wildlife Refuges, State Game management areas if biologists are available to survey them, and other areas that are notable for aquatic birds and that volunteers could probably be found to survey. Designated sites are numbered sequentially within BMRs.

The rest of each BMR is referred to as the matrix. It was sometimes divided into 2 or more "matrix strata". For example, one part of the matrix might support numerous aquatic species whereas the rest of it might have very few aquatic species. These two regions would probably be distinguished as two separate matrix strata. If the matrix stratum consists of well-defined sites, such as reservoirs or other water bodies, they may be numbered sequentially to facilitate development of a sampling plan for the stratum. The distinction between designated sites and individually-numbered sites in a matrix stratum is that all designated sites will be surveyed whereas only a (random) sample of the sites in matrix strata will be surveyed.

This report identifies species that regularly use each BMR in the State and presents lists of designated sites and matrix strata important to aquatic birds in each BMR. We hope it will help groups interested in initiating surveys for aquatic birds by identifying areas that warrant coverage and by describing the broad outlines of a sampling plan that may be used to select survey locations.

Idaho has two BMRs (Fig. 1). Each is discussed below.

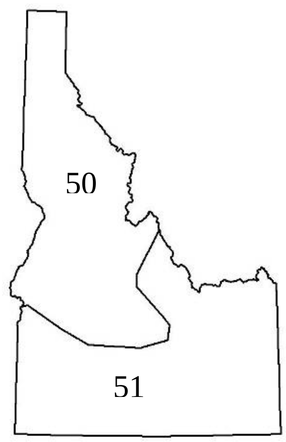

Fig. 1. Bird monitoring regions in Idaho.

Bird monitoring region 50: Idaho-Northern Rockies

This region covers the Northern Rockies region of Idaho. Approximately 65 aquatic species occur at least commonly, at some time of year, in the region (Table 1); 17 designated sites and 1 matrix stratum have been identified (Fig. 3, Table 2).

Table 1. Aquatic species that occur commonly in bird monitoring region 50 (M=migration, B=breeding season, W=winter).

Species	Seasons	Species	Seasons	Species	Seasons
Eared Grebe	MB	Blue-winged Teal	MB	American Avocet	MB
Pied-billed Grebe	MB	Cinnamon Teal	MB	Black-necked Stilt	B
Western Grebe	MB	Canvasback	MB	Willet	MB
American White Pelican	MB	Redhead	MB	Long-billed Curlew	MB
Double-crested Cormorant	MB	Ring-necked Duck	MB	Western Sandpiper	MB
American Bittern	MB	Lesser Scaup	MB	Common Snipe	MB
Blk-crowned Night-Heron	MB	Common Goldeneye	MW	Wilson's Phalarope	MB
Snowy Egret	MB	Bufflehead	M	Franklin's Gull	MB

Great Blue Heron	MB	Common Merganser	MW	Ring-billed Gull	MBW
White-faced Ibis	MB	Red-br Merganser	M	California Gull	MBW
Tundra Swan	M	Ruddy Duck	MB	Caspian Tern	MB
Canada Goose	MBW	Northern Harrier	MBW	Forster's Tern	MB
Wood Duck	MB	Bald Eagle	MW	Black Tern	MB
Mallard	MBW	Virginia Rail	B	Tree Swallow	M
Gadwall	MB	Sora	B	Violet-green Swallow	M
Green-winged Teal	MBW	American Coot	MB	Marsh Wren	MB
American Wigeon	MBW	Sandhill Crane	MB	Yellow-hdd Blackbird	MB
Northern Pintail	MBW	Killdeer	MB	Red-winged Blackbird	MBW
Northern Shoveler	MB				

Stratum 1: Designated Sites

Fig. 2. Designated sites and matrix strata in bird monitoring region 50

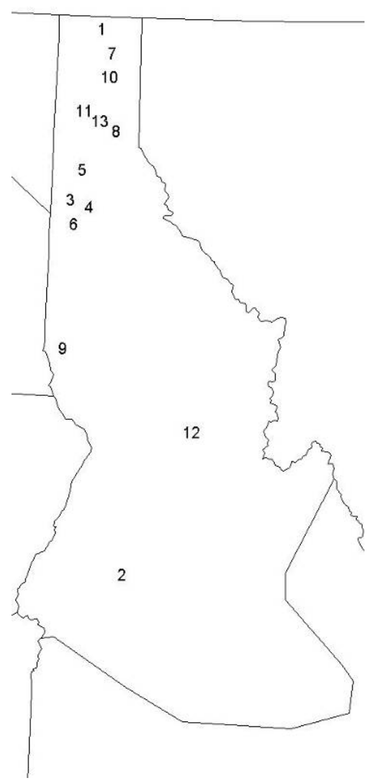

Table 2. Designated sites in bird monitoring region 50. Site descriptions are available in the Idaho CBM Plan (Moulton et al. 2004). (*to be completed after I talk with Colleen Moulton*)

Site ID	Site Name	Lat.	Long.	Importance to secretive marshbirds	Importance to migrating shorebirds	Comments
1	Boundary Creek WMA	48.98	-116.55		Medium	IBA
2	Cascade Reservoir	44.61	-116.10			IBA
3	Coeur d'Alene Lake	47.54	-116.83			

4	Coeur d'Alene R WMA	47.49	-116.61			
5	Hayden Lakes	47.78	-116.71			
6	Heyburn State Park	47.35	-116.78			IBA
7	Kootenai NWR	48.71	-116.41	Medium	Medium	IBA
8	Lake Pend Oreille	48.16	-116.35			IBA
9	Mann Lake	46.37	-116.85		Medium	IBA
10	McArthur Lake WMA	48.52	-116.45		Medium	IBA
11	Morton Slough	48.21	-116.68			IBA
12	Red River WMA	45.74	-115.39			
13	Westmond Lake	48.17	-116.54		Medium	IBA

Stratum 2: Northern Idaho (matrix stratum)

Stratum 2 includes all areas in BMR 50 that are not in designated sites. All of the focal species in the BMR occur in the stratum. Type 1 habitat includes all of the 24 lakes covering >300 acres. Type 2 habitat is all other lakes, ponds, and small wetlands. Survey methods have not been designed for the stratum but are expected to vary widely among the survey areas. Much of the Type I and Type II habitat is privately owned so gaining access will require careful planning.

Source: Site and matrix strata names are from the Idaho CBM Plan. No checklists were available for this region so 6 checklists from Montana (BMR 52) were used for the initial checklist.

Bird monitoring region 51: Idaho-Great Basin

This region covers southern Idaho. Approximately 65 aquatic species occur at least commonly, at some time of year, in the region (Table 3); 40 designated sites and 1 matrix stratum have been identified (Fig. 3, Table 4).

Table 3. Aquatic species that occur commonly in bird monitoring region 50 (M=migration, B=breeding season, W=winter).

Species	Seasons	Species	Seasons	Species	Seasons
Common Loon	MB	Blue-winged Teal	MB	Greater Yellowlegs	M
Horned Grebe	MB	Cinnamon Teal	MB	Lesser Yellowlegs	M
Eared Grebe	MB	Canvasback	MB	Solitary Sandpiper	B
Pied-billed Grebe	MB	Redhead	MB	Spotted Sandpiper	MB
Red-necked Grebe	MB	Ring-necked Duck	M	Long-billed Curlew	MB
Western Grebe	MB	Lesser Scaup	MB	Least Sandpiper	M
American White Pelican	MB	Barrow's Goldeneye	MW	Baird's Sandpiper	MB
Double-crested Cormorant	MB	Common Goldeneye	MBW	Pectoral Sandpiper	MB
American Bittern	M	Bufflehead	M	Long-billed	MB

				Dowitcher	
Black-crowned Night-Heron	MB	Common Merganser	MBW	Common Snipe	MB
Great Blue Heron	MBW	Hooded Merganser	M	Wilson's Phalarope	MB
Tundra Swan	M	Ruddy Duck	MB	Red-necked Phalarope	M
Trumpeter Swan	MBW	Osprey	MB	Franklin's Gull	MB
Snow Goose	M	Northern Harrier	MB	Ring-billed Gull	MB
Canada Goose	MBW	Bald Eagle	MBW	California Gull	MB
Wood Duck	MB	Sora	B	Forster's Tern	MB
Mallard	MBW	American Coot	MB	Black Tern	MB
Gadwall	MB	Sandhill Crane	MB	Tree Swallow	MB
Green-winged Teal	MB	Semipalmated Plover	M	Violet-green Swallow	MB
American Wigeon	MB	Killdeer	MB	Marsh Wren	MB
Northern Pintail	MB	American Avocet	MB	Yellow-headed Blackbird	MB
Northern Shoveler	MB	Willet	MB		

Stratum 1: Designated sites

Fig. 3. Designated sites and matrix strata in bird monitoring region 51

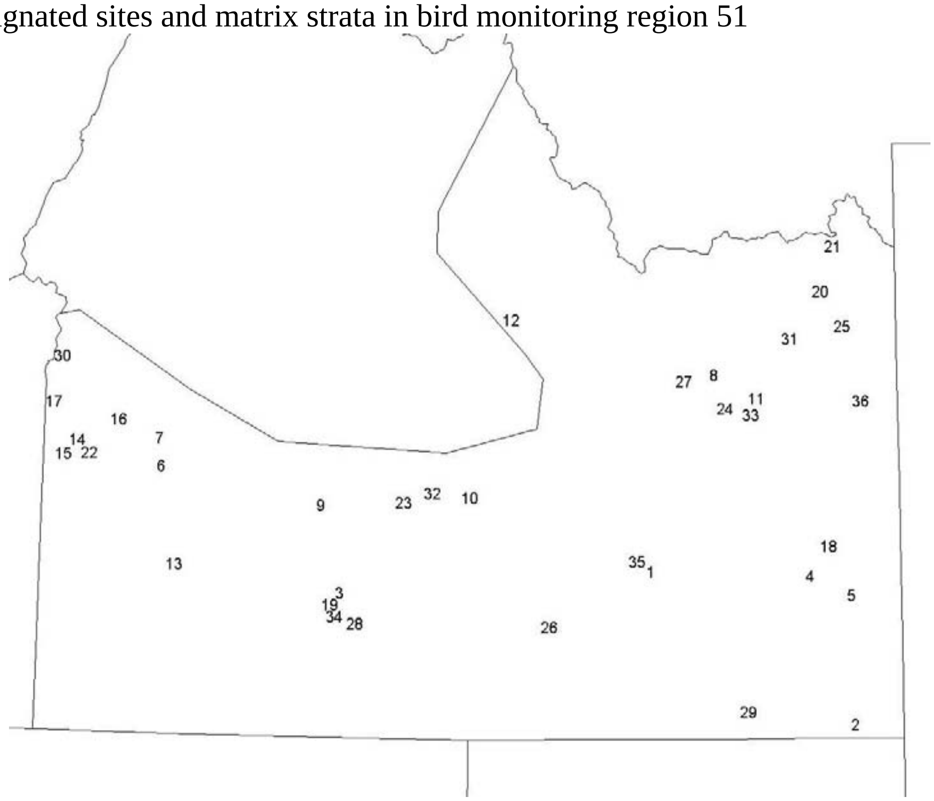

Table 4. Designated sites in bird monitoring region 51. Site descriptions are available in the Idaho CBM Plan (Moulton et al. 2004).

Site ID	Site Name	Lat.	Long.	Importance to secretive marshbirds	Importance to migrating shorebirds	Comments
1	American Falls Reservoir	42.95	-112.72		High	IBA
2	Bear Lake NWR	42.17	-111.32	Medium	High	IBA
3	Billinglsey Creek WMA	42.83	-114.88			
4	Blackfoot Reservoir	42.92	-111.61			IBA
5	Blackfoot River WMA	42.82	-111.33			
6	Blacks Creek Reservoir	43.45	-116.14		Medium	IBA
7	Boise River	43.59	-116.16			IBA
8	Camas NWR	43.94	-112.27	Medium	Medium	IBA
9	Camas Prairie Centennial Marsh WMA	43.27	-115.02			IBA
10	Carey Lake WMA	43.32	-113.92			IBA
11	Cartier Slough WMA	43.82	-111.91			IBA
12	Chilly Slough	44.12	-113.90			IBA
13	C.J. Strike Reservoir & WMA	42.96	-115.97		Medium	IBA
14	Deer Flat NWR	43.57	-116.67			IBA
15	Deer Parks Wildlife Mitigation Unit	43.55	-116.67			
16	Eagle Island	43.68	-116.39			IBA
17	Fort Boise WMA	43.76	-117.00		Medium	IBA
18	Grays Lake NWR	43.07	-111.42	Medium	Medium	IBA
19	Hagerman WMA	42.77	-114.88			IBA
20	Harriman Wildlife Refuge	44.36	-111.45			IBA
21	Henry's Lake	44.65	-111.40			
22	Lake Lowell	43.57	-116.67		High	IBA
23	Magic Reservoir	43.29	-114.38			IBA
24	Market Lake WMA	43.77	-112.13			IBA
25	Mesa Marsh	44.18	-111.30			IBA
26	Minidoka NWR	42.67	-113.36	Medium	Medium	IBA
27	Mud Lake WMA	43.91	-112.42		Medium	IBA
28	Niagara Springs WMA	42.68	-114.71			
29	Oxford Slough	42.24	-111.99	Medium		IBA
30	Payette River WMA	43.99	-116.80		Medium	
31	Sand Creek WMA	44.12	-111.67			
32	Silver Creek Preserve	43.34	-114.18			IBA
33	Snake River ACEC	43.77	-111.95			IBA
34	Snake River Island Wildlife Habitat Area	42.71	-114.85			IBA
35	Sterling WMA	43.00	-112.75			IBA

36	Teton County	43.80	-111.18			IBA

Stratum 2: Southern Idaho (matrix stratum)

Stratum 2 includes all areas in BMR 51 that are not in designated sites. All of the focal species in the BMR occur in the stratum. Type 1 habitat includes all of the 37 lakes covering >300 acres. Type 2 habitat is all other lakes, ponds, and small wetlands. Survey methods have not been designed for the stratum but are expected to vary widely among the survey areas. Much of the Type I and Type II habitat is privately owned so gaining access will require careful planning.

Source: Site and matrix strata names are from the Idaho CBM Plan. The species list was based on 3 checklists from the region.